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ETHOLOGY OF *NEOARATUS ABLUDO* DANIELS (DIPTERA: ASILIDAE) IN SOUTH AUSTRALIA, WITH NOTES ON *N. PELAGO* (WALKER) AND *N. RUFIVENTRIS* (MACQUART)[1]

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Abstract.—The predatory and mating behaviors of *Neoaratus abludo* Daniels were studied in paddocks south of Aldinga, SA. Although prey taken by *N. abludo* represented five insect orders, 62.5% of the prey were honey bees. The majority of matings, in the tail-to-tail position, took place in the afternoon. Incidental data are included on the distribution and behavior of *Neoaratus pelago* and *N. rufiventris*.

Key Words: Diptera, Asilidae, *Neoaratus abludo,* predatory behavior, mating, *Neoaratus pelago, Neoaratus rufiventris*

The present paper is the fourth in a series dealing with the behavior of South Australian robber flies. Previous papers dealt with *Neoitamus vittipes* (Macquart) (Lavigne 1982a), *Neoscleropogon elongatus* (Macquart) (Lavigne 1982b), and *Neocerdistus acutangulatus* (Macquart) (Lavigne 1984). In the first paper, definitions of asilid flight terminology were presented and therefore need not be repeated here.

While on sabbatical at the Waite Agricultural Research Institute (November 1978–May 1979), the author and his wife encountered a population of an undescribed species of *Neoaratus*, 8.5 km south of Aldinga, SA. The species, *Neoaratus abludo,* was subsequently described by Daniels (1983).

The population of *N. abludo* inhabited three hillside paddocks dominated by *Avena barbata* Pott ex Link, intermixed with *Echium plantagineum* L. (Salvation Jane), *Hypocheoris radieata* L., and *Scabiosa atropurpurea* L. (Fig. 1). The paddocks contained occasional trees, *Ficus macrophylla* Desj., *Albizzia lophantha* (Willd.) Benth. and *Acacia pycnantha* Benth., which had at one time received irrigation. A deep swale lined with *Pinus halepensis* Mill. (Aleppo pine) separated two of the paddocks. Within the swale were several additional flowering plants attractive to bees and wasps, *Cirsium vulgare* (Savi) Ten., *Convolvulus erubescens* (Willd.) Benth., *Carthamus lanatus* L. and *Sonchus olevaceus* L. At the west end of one paddock there was a stand of *Eucalyptus* trees within the eastern edge of which stood a row of 12 honey bee hives.

N. abludo was studied by the author and his wife during the period January 5 to 23, 1979 at this site. It was estimated that the asilid population contained approximately 150 individuals.

Because so little is known about the behaviors of members of the genus *Neoaratus,* notes on the behaviors of two additional species, *N. pelago* (Walker) and *N. rufiventris* (Macquart) have been included in this paper.

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Fig. 1. Paddock, 8.5 km south of Aldinga, SA, in which *Neoaratus abludo* was studied. Honey bee hives were located at the base of the *Eucalyptus* trees at the top of the picture.

Materials and Methods

Two methods of gathering data were utilized: (1) continuously observing single asilids for extended periods of time of varying lengths and (2) traversing of the area to obtain as large a number of behavioral observations for individual asilids as possible. On certain days, strong winds caused such extensive movement of the wild wheat that behavioral observations were impossible.

Observations, recorded in notebooks on site, included detailed records of foraging, feeding, mating and oviposition. Time of day and temperature for each activity also were recorded. As in previous studies, permanent photographic records of each behavior were obtained with the aid of a Nikon 35 mm, single lens reflex camera with a Micro-Nikkor-P.C. Auto 1:3.5, 55 mm lens.

Prey collections were made at every available opportunity by netting feeding robber flies or collecting prey at the termination of feeding. The asilids were then released unharmed and the prey were placed in a 7.5 ml vial with information on sex of predator, date and time of day. Prey were subsequently measured in the laboratory (from front of head to apex of abdomen) for prey size preference. Feeding asilids were sometimes observed for the duration of the feeding to obtain data on time spent feeding, prey manipulation and methods of prey discard. Fifteen specimens of each sex of the asilid were collected during the course of the study for size measurement in order to obtain a predator-prey ratio. This ratio is useful in comparing prey selection among asilid species (Dennis and Lavigne 1975), because apparently the size prey taken by individual species is limited in part by the size of the predator, the strength of its mouthparts, the predator's speed and the density of optimum sized prey in the asilid's environment (Lavigne and Holland 1969). Additionally it has been shown that female asilids discriminate between different shapes and colors (Dennis et al. 1975).

Prey were identified in so far as possible and then submitted to specialists for verification or identification beyond Order and Family, where necessary. The prey collec-

Fig. 2. *Neoaratus abludo* female feeding on the honeybee, *Apis mellifera,* in paddock dominated by *Avena barbata,* but containing many Salvation Jane plants attractive as nectar sources for honey bees.

tion is housed at Waite Agricultural Research Institute in Glen Osmond, Adelaide, SA.

Behavior

Foraging and Feeding Behavior

The selection of perch sites by *N. abludo* was presumably a function of chance, since stalks of lodged *Avena barbata* were the most dominant site in the environment.

The heights on plants, where resting and/or foraging individuals were observed, varied from 20 to 120 cm. Unlike many other asilid species, *N. abludo* was never noted landing on substrates other than vertical or semi-vertical plant stalks. Temperature control was maintained largely by moving to the shady side of the plant stalk when absorbed heat became excessive. When temperatures exceeded 36–37° C, asilids flew into the lower branches of trees or landed on fencing at greater heights than were available in the understory. At these higher temperatures, no foraging occurred.

All forage flights were directed at airborne insects. Distances covered in forage flights ranged from 20 cm to 2.2 m. Despite the large size (mean 31.85 mm) and rapid flight of *N. abludo,* prey sometimes eluded it. In one case a female landed dorsally on a honey bee, but was unable to hang on to it. Another time a female hovered behind a honey bee, but apparently misjudged the speed of the bee and missed it. Moths eluded asilids by zigzaging through the vegetation with the robber fly making several short darting flights at its target.

Once prey were captured, asilids would land on nearby vegetation, mainly *A. barbata,* or occasionally on paddock fences. Heights on vegetation where asilids fed on prey ranged from 15 cm to 1 m (mean 47 cm). Ordinarily, the impaled prey was held between the venter of the asilid and the stalk, with the predator's legs, fore and mid tarsi, being used to maintain position, thus encircling the prey (Fig. 2). The hind tarsi were sometimes used to grasp the stalk, also. Unless disturbed, the predator would remain on the landing site throughout the feeding. Occasionally the asilid would fly out 5 to 10 cm from the plant stalk, hover, manip-

Table 1. Relation between length of *Neoaratus abludo* and that of its prey.

Sex	Predator Length (mm)*			Prey Length (mm)			No. Prey Measured	Mean Ratio of Predator : Prey
	Min.	Max.	Mean	Min.	Max.	Mean		
Male	18.0	24.0	21.9	6.5	22.5	12.6	52	1.7
Female	19.0	24.5	21.9	4.0	23.0	12.1	117	1.8
Combined	18.9	24.5	21.9	4.0	23.0	12.2	169	1.8

* 15 predators of each sex were measured.

ulate the prey with all six tarsi and reland. Manipulation while hovering is exhibited also by *Neoitamus vittipes* (Lavigne 1982a). Upon completion of feeding, either prey were pushed off the asilid's proboscis on site, or, more often, dropped near the feeding site as the asilid flew after another potential prey.

One complete feeding encompassing 52 minutes was monitored. A male captured a moth, *Heliothis punctigera* Wallengt., in flight at 1428 h. Immediately, the asilid carried its prey ca. 2 m and landed on a dead plant stalk; the prey was impaled upon landing. The prey was held between the venter of the asilid and the stalk; the fore and mid tarsi grasped the stalk, while the hind tarsi rested on the prey's partially outstretched wings. At 1448 h, the asilid hovered for ca. 30 seconds, manipulated the prey with all six tarsi, repositioned its proboscis in the moth and relanded. At 1502 h the action was repeated. Thirteen minutes later, the asilid flew twice to new stalks, each time a distance of ca. 14 cm. At 1520 the male buzzed its wings and took flight after a honey bee, dropping the moth as it left its perch.

A partial (capture not observed) feeding time for a male *N. abludo* on the same species of moth two days earlier was 45 minutes. On two occasions, females, in copula, were observed to feed on honey bees for 40 to 50 minutes each.

Based on 169 measured prey of *N. abludo,* the "preferred" prey length was 12.2 mm; the size of the prey taken ranged from 4 to 23 mm (Table 1). Males and females were approximately the same size and tended to capture prey within the same size range. While males exhibited relatively equal "preference" for Hymenoptera (43%) and Lepidoptera (38%), females concentrated on Hymenoptera (81% of the prey taken). Distribution of prey selectivity for insect Orders is presented in Table 2. The mean predator to prey size ratio for *N. abludo* is 1.8, as compared to 2.9 for *Neoitamus vittipes* (Lavigne 1982a), meaning that *N. abludo* took much larger prey in comparison to its size than did *Neoitamus vittipes.*

Previous records of prey of members of the genus *Neoaratus* are few. Box (1953) listed *Pseudoholophylla furfuracea* as prey of *Neoaratus* sp. in Queensland. Nicholson (1931) photographed the capture of a honeybee (*Apis mellifera* L.) by *N. hercules* Wiedemann, while Hardy (1935) noted the capture of the same species by *N. inglorius* Macleay. While commenting on asilids feeding on asilids, Hardy (1950) reported on the capture of a male *N. murinus* Macquart by a female *N. hercules* Wiedmann. He additionally recorded the wasp, *Thynnus apterus* Oliver (Hymenoptera: Tiphiidae) as prey of a female *N. hercules.* More recently, Bristowe (1971) has recorded *Podalonia suspiciosa* (Hymenoptera: Sphecidae), *Apis mellifera* (Hymenoptera: Apidae) and an unidentified tachinid (Diptera) as prey of *N. pelago* Walker. No other published records of prey capture are known to the author.

In the present study 184 prey of *N. abludo* were collected over an 18 day period. On some days strong winds, those exceeding 28 km/h, interfered with the flight habits of both predator and potential prey. Predators did not fly, nor did potential prey, and thus no records were obtained. On days of extreme calm, as many as 11 prey per hour

Table 2. Numbers and percentage of prey of different Orders taken by *Neoaratus abludo*.

Order	Male		Female		Unknown		Total	
	#	%	#	%	#	%	#	%
Coleoptera	6	3.3	5	2.7			11	6.0
Diptera	4	2.1	1	0.5			5	2.7
Hemiptera-Heteroptera	1	0.5	2	1.1			3	1.6
Hymenoptera	25	13.6	97	52.7	6	3.3	128	69.6
Lepidoptera	22	12.0	15	8.2			37	20.1
Total	58	31.5	120	65.2	6	3.3	184	100.0

were collected from asilids by the observers at peak feeding times.

As can be seen in the following list, collected prey represented five Orders of insects. Selection of prey from such a limited number of Orders implies a stenophagic habit (Lavigne and Holland 1969). This narrowness of preference is further supported by the fact that 62.5% of the prey were honey bees and a further 12.5% were *Heliothis punctigera*. That *N. abludo* was selectively choosing honey bees is also supported by the fact that large numbers of males and females could be found in early afternoon resting on *Avena* stalks over a semi-circular area fronting the row of honey bee hives, usually at a distance of approximately five meters from the hives. Honey bees were particularly vulnerable to attack on days when wind speed exceeded 16 km/h. Because of the position of the hives, worker bees were forced to fly more or less directly into the wind on their outward foraging flights, thereby being slowed. Additionally their dark color, contrasted with the light background of drying *Avena* stalks, made them easily visible over long distances. The habit of asilids preying largely on honeybees is not unique and has been documented on numerous occasions (Adamovic 1963, Bromley 1930, 1942, 1945, 1946, 1948).

Herein is a list of prey taken by *N. abludo*. Specific identifications were obtained for the majority of prey, but because of the state of knowledge in some groups only genus and/or family designations can be included at this time. The number of records and sex of the predator are indicated in parenthesis following the prey record.

COLEOPTERA, Chrysomelidae: *Cassida mera* Germ., 19.i.79 (♀); Scarabaeidae: *Liparetrus* 8.i.79 (♀), 9.i.79 (5 ♂, ♀), 18.i.79 (♂, ♀), 19.i.79 (♀). DIPTERA, Calliphoridae: *Calliphora nociva* Hardy, 16.i.79 (♂). Muscidae: *Australophyra rostrata* (R.-D.), 6.i.79 (♀). Tachinidae: *Chaetophthalmus* sp., 5.i.79 (♂), 10.i.79 (♂). Tipulidae: *Austrolimnophora* sp., 8.i.79 (♂). HEMIPTERA-HETEROPTERA, Pentatomidae: *Cermatulus nasalis nasalis* (Westw.), 8.i.79 (♂); *Dictyotus caenosus* (Westw.), 19.i.79 (♀), 23.i.79 (♀). HYMENOPTERA, Apidae: *Apis mellifera* L., 5-23.i.79 (20 ♂, 89 ♀, 6 ?). Halictidae: *Lasioglossum lanarium* Sm., 6.i.79 (♀), 10.i.79 (♂), 18.i.79 (♀); *Lasioglossum* sp., 23.i.79 (♀). Ichneumonidae: *Lissopimpla excelsa* (Costa), 16.i.79 (♀), *Netelia* sp., 5.i.79 (♂). Pompilidae: *Cryptocheilus* sp., 10.i.79 (♂). Sphecidae: *Podalonia suspiciosa* Sm., 19.i.79 (♀). Tiphiidae, Thynninae, 8.i.79 (♂), 9.i.79 (♂, ♀). LEPIDOPTERA, Lycaenidae: *Zizula otis labradus* (Godart), 16.i.79 (♂). Noctuidae: *Agrotis infusa* (Boisduval), 10.i.79 (♂); *Heliothis punctigera* Wallengt., 8.i.79 (♀), 9.i.79 (2 ♂, 2 ♀), 10.i.79 (♂), 11.i.79 (♂), 16.i.79 (4 ♂, 2 ♀), 18.i.79 (4 ♂, 2 ♀), 19.i.79 (2 ♂, 2 ♀); *Pseudaletia convecta* (Waller), 5.i.79 (♀). Pyralidae: *Etiella* sp., 11.i.79 (♀); Phycitinae, 10.i.79 (♂), 19.i.79 (♀), 23.i.79 (♀).

Orientation Flights

Long flights of 10^{+} m were often initiated by asilids after they remained in one loca-

Fig. 3. Mated pair of *Neoaratus abludo* in tail-to-tail position with male holding onto stalk below female.

tion for an extended period. Presumably this was a response to lack of potential prey in the immediate vicinity. However, it could also be a strategy used by males to relocate, when sufficient time has passed without a female being sighted.

Mating

Initiation of mating was observed in 10 instances out of 113 observed pairs in copula. No evidence of courtship behavior was exhibited by these males. The male would fly up from a resting position and intercept a female flying by or in the process of landing. In five out of 10 cases, the accosted female was carrying prey when forced into the vegetation for copulatory purposes. Out of the 113 mated pairs, 14% of the females were feeding on prey when observed, 69% of which were honey bees. It is assumed that females had obtained prey prior to copulating, although females of some species fly out after prey while in copula.

Males, in the presence of females, acted somewhat differently on two occasions. In one instance, a male flew into the vicinity of a stalk of Salvation Jane upon which a female was resting, and three times performed an arcing flight in front of her. The female then flew off with the male in pursuit. On another occasions a male three times circled a stalk upon which a female was resting and then landed on her dorsum and copulated with her.

The entire mating sequence was observed on three occasions. In each case the male flew out of the vegetation and accosted a female in flight (2 times) or just after landing (once). In the former instances copulation took place where the female was forced down into the vegetation. The initial position taken was that of male atop female, but within seconds the pairs took the tail-to-tail position which they maintained thereafter. Once this position was attained, the pair remained quiet throughout the copulatory period. As can be seen in Fig. 3, the male may take a somewhat abnormal rotated position in relation to the female, depending on the availability of vegetation to grasp. The male is able to do this because, like many other Dasypogoninae, it has a hypopygium rotated around the longitudinal axis of the abdomen (Snodgrass 1902, Hardy 1944, Karl 1959). Occasionally during a mating when the pair took a vertical position on an *Avena* stem, the female would be observed clutching the stem with all six tarsi while the male hung in mid-air, with only his claspers maintaining contact.

Pair separation was observed on 12 occasions. Twice pairs separated in flight after being disturbed. Seven times males merely released their claspers and flew off leaving the female on site. On three occasions females were observed pushing with their hind

Fig. 4. Female *Neoaratus abludo* ovipositing within the glume of a shattered seed head of *Avena barbata*.

tarsi at the genitalic juncture. Total times in copula for the three complete matings were 40, 45 and 50 minutes.

Mated pairs were observed (Fig. 5) at all times from 1000 to 1707 h, although the greatest number were observed between 1200 and 1300 h. Daniels (1983) observed pairs in copula between 0830 hr and 1230 hr. Temperatures taken at the heights mated pairs were observed ranged from 24° to 38°C (mean 31.3°C). Mated pairs were observed resting on stalks of *A. barbata* at heights ranging from 15 to 91 cm (mean 37.5 cm). On days when temperatures exceeded 33°C, mated pairs would sometimes fly onto the lower branches of trees at heights of 2 to 2.5 m, presumably to reduce heat absorption.

Male to male encounters were common, presumably because of the inability of males to recognized females until a close encounter occurred. In these instances the asilids would rise straight up in the air 3–4 m, "squaring off" in front of each other. Occasionally brief contact would occur. Although not monitored, it is presumed that males exhibited searching flights that would place them in the vicinity of females, a strategy used by males of some other asilid species, such as *Efferia benedicti* (Bromley) and *E. pallidula* (Hine) (Lavigne et al. 1976, Lavigne and Holland 1969).

Oviposition

A description of the eggs and oviposition behavior have been published by Lawson and Lavigne (1984). Figure 4 illustrates the position taken by the female during oviposition

Daily Rhythm of Activity

Detailed information on daily activity patterns has been published for a variety of species of Wyoming asilids (Dennis and Lavigne 1975, Lavigne et al. 1976), but for only one Australian species, *Neocerdistus acutangulatus* (Lavigne 1984). In Fig. 5, data are presented for *N. abludo*. While the majority of oviposition by females of *N. acutangulatus* occurs in early afternoon, females of *N. abludo* deposit eggs mostly in the morning. While females are searching for oviposition sites, it is unlikely that they

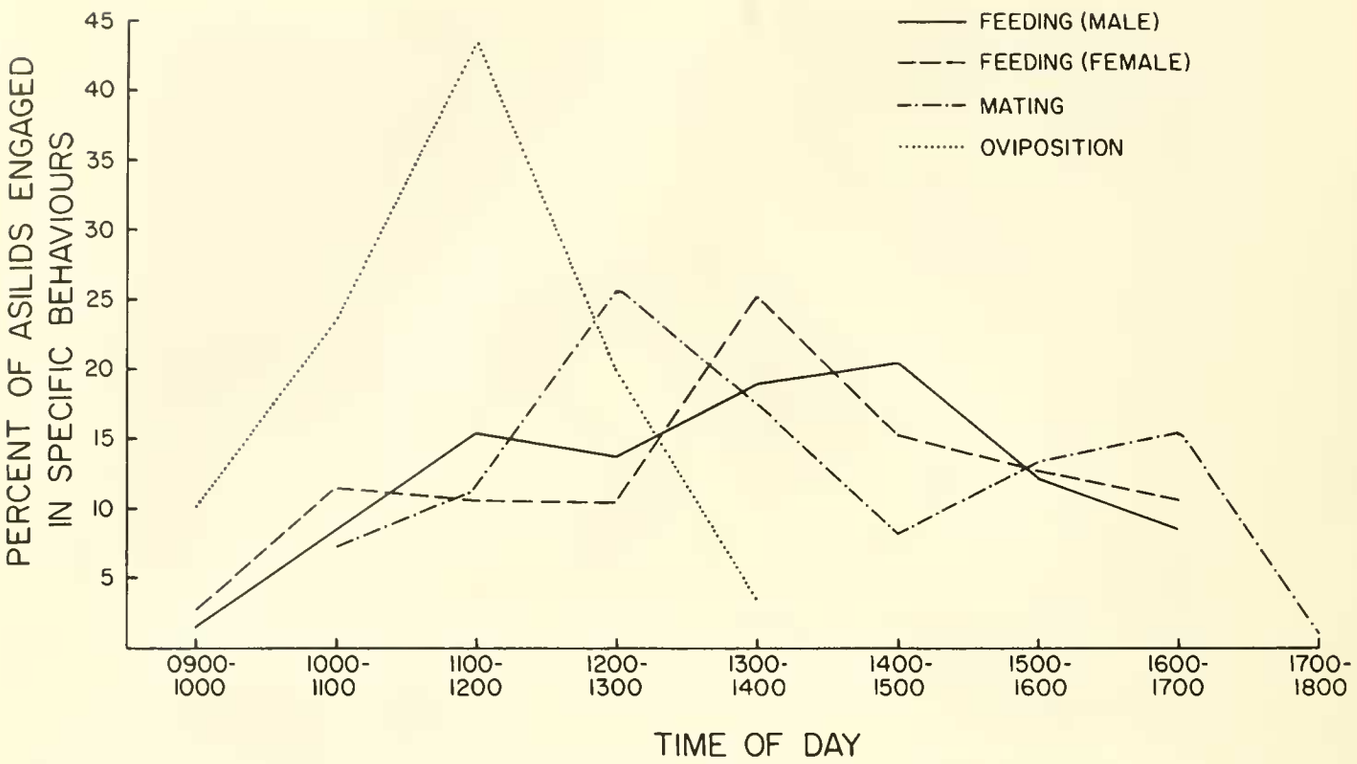

Fig. 5. Mean diurnal rhythm of activity for *Neoaratus abludo* 8.5 km south of Aldinga, SA. Percentage of asilids engaged in specific behavior patterns was calculated from the total number of observations for each behavior.

would be interested in feeding or be available for copulation, and this is reflected in Figure 5. Peak feeding by females and peak mating periods occur in the afternoon. Males of *N. acutangulatus* fed primarily in the morning, whereas *N. abludo* males tend to feed in early afternoon between the two mating peaks.

Predators

While it is assumed that some *N. abludo* fell prey to birds, since birds have been noted commonly as asilid predators (McAtee 1932, Adamovic 1963), the only observed acts of predation against this species were by spiders. Asilids probably become entangled in the vertical webs of large spiders in the process of chasing prey. On four occasions specimens of *N. abludo* were removed from webs containing the common large spider, *Araneus transmarinus* Keyserling (Fig. 6). Honey bees also were found in the webs of these spiders, wrapped in silk.

Fig. 6. A spider, *Araneus transmarinus*, with a specimen of *Neoaratus abludo* in its grasp.

Neoaratus pelago (Walker)

This species, originally placed in the genus *Asilus*, was described by Walker in 1849. Ricardo (1913) recorded it from Swan River and Adelaide, South Australia, while Hardy (1920) discovered it in Perth, Western Australia. By 1935, the latter author had accumulated specimens from Victoria and Queensland as well, noting that "this fly evidently occurs wherever Mallee and sclerophyll woodlands, and scrub of a similar nature, are to be found" (Hardy 1935).

Specimens of *N. pelago* were collected at only two locations in South Australia: 5 km

west of Sedan (5.ii79) and Ferries-McDonald Conservation Park, South of Monarto (31.i.79, 1.ii.79). The vegetation complex at both sites was Mallee scrub. The overstory at Ferries-McDonald consisted of *Melaluca uncinta* and *Eucalyptus* sp., while the understory was composed largely of *Helichrysum leucopsideim* DC., *Hibbevtia stricta* (DC) F. Muell., *Cryptandra leuchophraeta* Schldl., *Hypolaena fastigiata* R. Br. and *Lepidosperma carphoides* F. Muell.

Zigzag orientation flights of 3 to 6 m among upright vegetation were made between non-vegetated sandy areas, whereas straight flights of less than 1 m were made within these clearings. Asilids in flight produced a loud buzzing sound. Landings were made on small rocks and broken limbs of Mallee lying on the sand. Three to five minutes were spent in each non-vegetated area. At Ferries-McDonald one robber fly made a foraging flight of one meter making contact with a large wasp, but was unable to subdue it and the prey escaped. At the site west of Sedan, a female *N. pelago* was collected with a grasshopper of an undescribed genus as prey. During a period of 12 minutes, the asilid three times flew out 5 cm from the feeding site, hovered, manipulated the grasshopper using all six tarsi, reinserted its proboscis and landed on a nearby branch.

Neoaratus rufiventris (Macquart)

Originally described by Macquart in 1838 in the genus *Asilus*, this species has been found in Queensland (Toowomba), New South Wales, Victoria (Moreton Bay) and South Australia (Ricardo 1913, Hardy 1920, 1935).

Specimens of *N. rufiventris* were encountered at only two locations in South Australia by the author: 16 km north of Kingston, at the edge of a dryland lucerne field, opposite the Coorong Game Reserve (18.xii.78) and within a wood just off the freeway outside Mt. Barker (2.iii.79). The latter location contained an overstory of *Eucalyptus leucoxylon* FrM. with an understory of *A. barbata*, intermixed with *Cirsium* sp. and a patch of *Ulex europaeus* L.

A single observed male at the Coorong site was collected with a beetle, *Liparetrus* sp. (Coleoptera: Scarabaeidae) as prey.

At the Mt. Barker site the population consisted of a very few individuals. A captured specimen had badly frayed wings suggesting that it had emerged several weeks earlier. Orientation flights initiated from dry plant stalks, bent *A. barbata* stems, and fallen *Eucalyptus* limbs, covered distances of ca. 8 m.

A mated pair in the tail-to-tail position was observed at Mt. Barker (2.iii.79) at 1145 h resting on a dry plant stalk at a height of 0.7 m. The temperature at the mating height, under an overcast sky, was 25°C. The pair moved several times during the ensuing 18 minutes always landing on dry plant stalks at the same approximate height. During one weaving flight at a height of 1.7 m, a male accosted the mated pair in the air landing atop the female as the pair landed. In this position the second male made a number of copulatory attempts prior to being dislodged several seconds later. A few minutes later, 1203 h, the mated pair separated upon landing with the male flying away. The female remained on the landing perch and cleaned her wings, hind tarsi and ovipositor in succession. At 1310 h a dense fog inundated the site and individuals were observed flying up into the lower branches of the *Eucalyptus* trees.

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Literature Cited

Adamovic, Z. R. 1963. Ecology of some asilid-species (Asilidae, Diptera) and their relation to honey bees (*Apis mellifica* L.). Museum d'Histoire Naturelle de Beograd, Hors Serie 30: 1–102 (In Serbian, English Summary).

Box, H. E. 1953. List of sugar-cane insects. Commonwealth Institute of Entomology, Queens Gate: London. 83 pp.

Bristowe, W. S. 1971. The habits of a West Australian sphecid wasp. Entomologist 104: 42–44.

Bromley, S. W. 1930. Bee-killing robber flies. Journal of the New York Entomological Society 38: 159–176.

———. 1942. Bee-killing asilids in New England. Psyche 49: 81–83.

———. 1945. The robber flies and bee-killers of China (Diptera: Asilidae). Lingnan Sci. J. 21(1–4): 87–105.

———. 1946. Bee-killing Asilidae of the Southeastern States (Diptera). Proceedings of the Entomological Society of Washington 48: 16–17.

———. 1948. Honey-bee predators. Journal of the New York Entomological Society 56: 195–199.

Daniels, G. 1983. A new species of *Neoaratus* Ricardo (Diptera: Asilidae). Journal of the Australian Entomological Society 22: 233–236.

Dennis, D. S. and R. J. Lavigne. 1975. Comparative behavior of Wyoming robber flies II (Diptera: Asilidae). University of Wyoming Agricultural Experiment Station Science Monograph No. 30. 68 pp.

Dennis, D. S., G. P. Roehrkasse, and R. J. Lavigne. 1975. Prey recognition by *Efferia frewingi* (Diptera: Asilidae). Annals of the Entomological Society of America 68: 404–408.

Hardy, G. H. 1920. On the male genitalia of some robber-flies belonging to the subfamily Asilinae (Diptera). Proceedings of the Linnean Society of New South Wales 45 (Pt. 2): 250–259.

———. 1935. The Asilidae of Australia. Part III. Annals and Magazine of Natural History (10)16: 161–187.

———. 1944. The copulation and the terminal segments of Diptera. The Proceedings of the Royal Entomological Society of London (Series A) 19: 52–65.

———. 1950. Capturing an elusive robberfly (Dipt., Asilidae). The Entomologist's Monthly Magazine 86: 345–346.

Karl, E. 1959. Vergleichend-morphologische Untersuchungen der mannlichen Kopulationsorgane bei Asiliden. Beitrage Zur Entomologie 9: 619–680.

Lavigne, R. J. 1982a. Ethology of *Neoitamus vittipes* (Diptera: Asilidae) in South Australia. Proceedings of the Entomological Society of Washington 84: 617–627.

———. 1982b. Notes on the ethology of *Neoscleropogon elongatus* (Diptera: Asilidae) in South Australia. Proceedings of the Entomological Society of Washington 84: 742–745.

———. 1984. Ethology of *Neocerdistus acutangulatus* (Diptera: Asilidae) in South Australia. Proceedings of the Entomological Society of Washington 86: 422–431.

Lavigne, R. J. and F. R. Holland. 1969. Comparative behavior of eleven species of Wyoming robber flies (Diptera: Asilidae). University of Wyoming Agricultural Experiment Station Science Monograph No. 18. 61 pp.

Lavigne, R. J., L. Rogers, and F. Lavigne. 1976. Ethology of *Efferia benedicti* (Diptera: Asilidae) in Wyoming. Proceedings of the Entomological Society of Washington 78: 145–153.

Lawson, F. A. and R. J. Lavigne. 1984. Oviposition and eggs of an Australian robber fly, *Neoaratus abludo* Daniels (Diptera: Asilidae). Proceedings of the Entomological Society of Washington 86: 773–776.

McAtee, W. L. 1932. Effectiveness in nature of the so-called protective adaptations in the animal kingdom, chiefly as illustrated by the food habits of Nearctic birds. Smithsonian Miscellaneous Collections 85: 1–201.

Nicholson, A. J. 1931. Methods of photographing living insects. Bulletin of Entomological Research 22: 307–320.

Ricardo, G. 1913. XLIX.—A revision of the Asilidae of Australasia. Annals and Magazine of Natural History (8)11: 429–451.

Snodgrass, R. E. 1902. The inverted hypopygium of *Dasyllis* and *Laphria*. Psyche 9: 399–400, pl. 5.